THE
SHORT METHOD CALCULATOR

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PREFACE.

The object of this book is to teach all of the practical short rules in arithmetic not taught in institutions of learning, nor found in school manuals. The author has taken great pains to make the rules simple, clear, brief and complete. A person with an ordinary school education can readily understand the rules and apply them. The special calculations will surely be of immense value to men in any trade, profession or occupation; and even thorough mathematicians will find very many new rules and methods, which can be relied upon, having been computed, proven and proof-read with rigid exactness, and have never been published before, especially the rules pertaining to the triangle and circle.

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DECIMAL EQUIVALENTS.

1/64	....	=	.015625
1/32	....	=	.03125
3/64	....	=	.046875
1/16	....	=	.0625
5/64	....	=	.078125
3/32	....	=	.09375
1/8	....	=	.125
3/16	....	=	.1875
1/4	....	=	.25
5/16	....	=	.3125
3/8	....	=	.375
7/16	....	=	.4375
1/2	....	=	.5
9/16	....	=	.5625
5/8	....	=	.625
11/16	....	=	.6875
3/4	....	=	.75
13/16	....	=	.8125
7/8	....	=	.875
15/16	....	=	.9375
1	....	=	1

DISCOUNT SUBTRACTION.

If a bill of goods amounts to $756.00, and a discount of 7% is allowed, what is the net amount?

Ordinary Method.	Short Rule.
$ 756.00	$756.00
.07	.07
$52.9200	$703.08
$ 756.00	
52.92	
$ 703.08	

EXPLANATION.—Multiply 756 by 7 and write for the answer figures which, when added to the product thus obtained, will be equal to 762.00; *viz.*: $7 \times 6 = 42$, as 8 is necessary to make 50 (next higher order of tens) as we have 0 on the right, so write down the 8 in the answer and carry 5, next say $7 \times 5 = 35$ and add the 5, making 40. As unit figure is 0, same as above, write 0 in the answer and carry 4, $7 \times 7 = 49$ and add the 4, making 53. Place the 3 in the answer, the 5 equals the 5 above, so write 0 in the answer and bring down the 7 completing the answer.

To multiply any number by 25, divide by 4 and your answer will be in hundredths.

As, $25 \times 25 = 4\overline{)25} = 625$, etc.
$6\frac{1}{4}$

GOODS BOUGHT BY THE DOZEN.

As many articles are sold by the dozen at wholesale, it is a matter of great importance to the merchant to be able to decide the retail selling price of one article at a certain profit as quickly as possible.

To make	20	per cent.	divided cost	per doz. by	10				
"	33⅓	"	"	"	9				
"	50	"	"	"	8				
"	100	"	"	"	6				
"	40	"	"	"	10	and	add	1/6	itself
"	35	"	"	"	10	"	"	1/8	"
"	37½	"	"	"	10	"	"	1/7	"
"	30	"	"	"	10	"	"	1/12	"
"	25	"	"	"	10	"	"	1/24	"
"	12½	"	"	"	10	and	subtract	1/16	itself
"	16⅔	"		"	10	"	"	1/36	"
"	18¾	"	"	"	10	"	"	1/96	"

EXAMPLE.—To make 20 per cent. on one dozen hats which cost $37.50 per dozen, simply move the decimal point one place to the left, which is the same as dividing by 10, and we have $3.75; the price each hat must be sold for.

LIGHTNING ADDITION.

Lightning addition can easily be acquired if the pupil will devote a short time each day for a few weeks, as practice is necessary to become rapid in grouping the figures to be added.

For instance, you must not look upon 2, 5, 7 as 2 + 5 + 7 = 14. You must see at once that it is 4, and remember that you have dropped the 10. If your next figures are 7, 9, 4 they will read 0 and drop the 20, etc.

A good plan is to mark a lot of cards, each one different, shuffle them and pick one out and see how quickly you can add the figures. A little practice will surprise you. A good idea at first is to mark your cards something like this:

5 5 5 5 5 5 5 5 5
2 2 2 2 2 2 2 2 2
1 2 3 4 5 6 7 8 9

4 4 4 4 4 4 4 4 4
1 2 3 4 5 6 7 8 9
1 2 3 1 2 3 1 2 3

THE COMPLEMENT RULE.

The complement of any number is the difference between that number and the unit of the next higher order, *viz.*, the complement of 92 is 8; of 96 is 4; of 983 is 17, etc., etc. Multiply 92 × 96.

Old Method.

92
96

552
828

8832 Ans.

Short Rule.

92^{08}
96^{04}

8832 Ans.

First multiply the complements, 8 and 4, place the product, 32, in the answer. Now subtract across either 4 from 92 = 88, or 8 from 96 = 88.

TO PROVE SUBTRACTION.

7543	=	19	=	10	=	1
5674	=	22	=			4
1869	=	24	=			6

As the minuend is less than the subtrahend, we must add 9 to the minuend before we can subtract. We have 6 for a unitate, both in the sum and the answer, proving the work correct.

RULE:—Add $7 + 5 + 4 + 3 = 19$; add $1 + 9 = 10$; $1 + 0 = 1$; add $5 + 6 + 7 + 4 = 22$; add $2 + 2 = 4$. As 1 is less than 4, add $1 + 9 = 10$, subtract $10 - 4 = 6$ (unitate).

BUYING GOODS BY THE GROSS.

\$35.00 per gross $= 35 \times 7 = 24.5$c. each or 24½c. each.

As 144 is contained in 1,000 seven times (very nearly) multiply the gross price in dollars by 7. This gives us the price each article will cost; near enough for any business.

MULTIPLICATION OF TEENS.

17	18	16	15	12
14	19	13	15	12
238	342	208	225	144

EXPLANATION.—Multiply units by units, and carry. Next add units and units, and increase left-hand figure by one.

PROOF OF DIVISION.

EXAMPLE:

$$\begin{array}{cccc} (7) & (5) & (9) \\ 124\ ) & 349367 & (\ 2817 \\ \text{Rem.} & 59 & \\ & (5) & \end{array}$$

EXPLANATION.—The product of the divisor and quotient plus the remainder is equal to the dividend. After casting out the nines, we have the following unitates:

	Dividend unitate	....		(5)
Multiply	Divisor "	....	7	
	Quotient "	....	9	
Add	Product "	....	63 = 9	
	Remainder "	....	5	
			14 = (5)	

Therefore, the work may be assumed to be correct as both unitates are the same.

ADDITION OF FRACTIONS.

To add 3/8 and 4/17:

$$\frac{51 + 32}{\frac{3}{8} + \frac{4}{17}} = \frac{83}{136}$$

RULE.—$3 \times 17 = 51$. Place 51 above the 3/8. $4 \times 8 = 32$. Place 32 above 4/17. Next add 51 and $32 = 83$, which is the numerator of your answer. Multiply $8 \times 17 = 136$, which is the denominator, completing the answer.

CONTRACTED METHOD.

Find the cost of $42\frac{3}{4}$ lbs. of butter at $32\frac{1}{4}$c. per lb.

$$
\begin{array}{rcrcrcl}
32.25 & & & & & & \\
752.4 & & & & & & \\
\hline
 & & & & & & \text{Carry.} \\
12.90 & = & 322 & \times & 4 & + & 2 \\
64 & = & 32 & \times & 2 & + & 0 \\
22 & = & 3 & \times & 7 & + & 1 \\
2 & = & 0 & \times & 5 & + & 2 \\
\hline
\$13.78 & \text{Ans.} & & & & &
\end{array}
$$

RULE:—Reverse the order of the figures in the multiplier, leaving the units (2) under the units (2). Multiply one figure to the right merely to find how many to carry.

To multiply any number by 14, 19, 106, 108, 103, etc.:

$$
\begin{array}{ll}
30314 \times 14 & \\
121256 & \\
\hline
424369 = \text{Ans.} &
\end{array}
\qquad
\begin{array}{ll}
30314 \times 103 & \\
\;\;90942 & \\
\hline
3122342 = \text{Ans.} &
\end{array}
$$

RULE:—Instead of writing down the 14 and multiplying in the ordinary way, multiply by the 4 only, placing the product one figure to the right, and add.

In the second example, multiply by the 3 only, and place the product two figures to the right. This method saves a lot of time.

SURFACE OF A SPHERE.

To find the surface of a sphere when the diameter is given, proceed as follows: Square the diameter and multiply by 3.1416.

USEFUL FACTS IN HYDRAULICS.

Doubling the diameter of a pipe increases the capacity four times.

Circular apertures are most effective for discharging water, since they have less frictional surface for the same area.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. (Approximately every foot of elevation is considered equal to ½ lb. pressure per square inch.)

The time occupied in discharging equal quantities of water, under equal heads, through pipes of equal lengths, will be different for varying forms, and proportionally as follows: For a straight line, 90; for a true curve, 100; and for a right angle, 140.

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13 CHECK FIGURE.

To apply the 13 check figure, cast out all multiples of 13, as 13, 26, 39, 52, etc. The remaining figure is the proof figure. If the proof figure is not the same in the body of your example as in your answer, your answer is not correct. Proceed as follows:

$$\left.\begin{array}{r} 19816 = 4 \\ 28734 = 4 \\ 52067 = 2 \end{array}\right\} = 10$$

$$\begin{array}{rl} \hline 100617 = & \qquad 10 \end{array}$$

APPLICATION.—13 from 19 leaves 6; affix the 8. 65 (13 × 5) from 68, 3 remains. 26 (13 × 2) from 31, 5 remains. 52 (13 × 4) from 56, 4 remains, etc., etc.

One ton of soft coal is equal to two cords of hard wood for making steam.

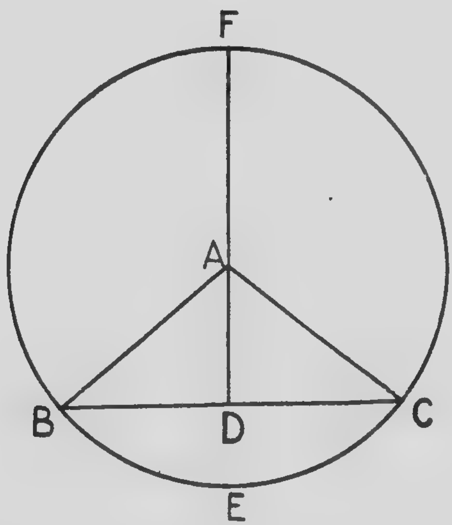
THE CIRCLE.

Archimedes found that the circumference of any circle was nearly 3 1/7 times the diameter. If the exact ratio could be found the process of squaring or quadraturing the circle would be accomplished by figures. Thousands of persons have claimed in almost as many different ways the accomplishment of this impossibility. The ratio of the diameter to the circumference has been found to over 600 decimal places. The following ratios will answer all practical purposes.

RULE:—Multiply the diameter by 3.1416, or, for greater accuracy, by 3.141592653, or multiply the area by 12.566 and extract the square root of the product.

We will append the following, which gives the ratio of the diameter to the circumference to be as
1 to 3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862803482534211706798214808651328230664709384 + to infinity.

[NOTE—The circle has never been so fully explained before in books of this sort, especially in such short rules. —AUTHOR.]



To find the area of a segment of a circle, proceed as follows: Multiply the total area of the circle by the number of degrees in the arc, and divide by 360. This will give you the area of the sector (A, B, C, E). Deduct the area of the two triangles (A, B, D and A, D, C) and the remainder is the area of B, C, E.

To find the length of the chord (B, C) multiply the height of the segment (D, E) by the remainder of the diameter (D, F) and the result is equal to B, D × D, C. Of course, A B and A C are each equal to ½ of the diameter, and A, D + D, E = A, B.

To find the height of an arc, take half the diameter and half the chord, multiply their sum by their difference, and subtract the square root of the product from half the diameter.

AREA OF A SECTOR.

To find the area of a sector, divide the number of degrees in the arc of the sector by 360, multiply the result by the area of the circle, of which the sector is a part.

AREA OF A SEGMENT.

To find the area of a segment, divide the diameter by height of segment, subtract .608, extract square root of the remainder, multiply by 4 times square height of segment and divide by 3.

SIDE OF AN EQUAL SQUARE.

To find the side of an equal square of a circle, multiply diameter by .8862.

LENGTH OF AN ARC.

To find the length of an arc of a circle, multiply length of circumference by number of degrees in arc and divide by 360.

TO FIND LENGTH OF ANY CHORD.

A good short method of obtaining the length of any chord of a circle is to multiply the height of the arc by the remainder of the diameter, extract the square root of the product, and multiply the result by 2.

TO FIND DIAGONAL OF A SQUARE.

When the side of a square is given, to find the diagonal: Multiply the side of the square by 1.41421; or, multiply by 99 and divide by 70.

TO FIND DIAMETER OF CIRCLE.

To find the diameter of a circle when length of chord and height of arc only are given.

RULE.—Divide the square of half the chord by the height of the arc and add the given height.

OPERATION.—Length of chord 56 inches and height of arc 8 inches. To find the diameter.
$56 \div 2 = 28$, 28 squared $= 784$, $784 \div 8 = 98$, $98 + 8 = 106$. Ans. 106 inches diameter of circle.

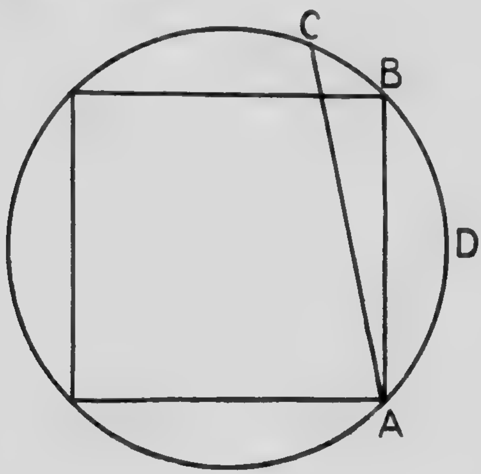
DEGREES IN ARC OF CIRCLE.

Multiply length of arc by 360, and divide by the circumference.

TO FIND LENGTH OF UNKNOWN SIDE.

To find the length of one side of a rectangular solid, when the cubic contents and the length of two sides are given.

RULE.—Divide the cubic contents by the product of the two given sides.



In the above we find that one side of the square (A and B) takes in ¼ of the circle, the diameter of which we will assume is 10 inches. This gives 31.416 inches of circumference, ¼ of which (31.416 ÷ 4) is 7.854 inches. If we were to straighten out the arc A, D, B it would reach from A to C or 2/7 of the circumference, or 8.976 inches. Making A, C 1.122 inches longer than A, B, and as 1.122 inches is 1/7 of .785 inches, 4 arcs straightened would span 4.488 inches more than the circumference of the circle.

CIRCLE OF EQUAL AREA TO GIVEN SQUARE.

Simply multiply side of the square by 1.12838. The result will be the diameter of a circle containing the same area as the square.

9 CHECK FIGURE.

To apply the 9 check figure, cast the nines out and reduce both the sum you have added and the answer found to a unitate to prove the addition correct.

EXAMPLE:

124863	= 24		= 6	
345342	= 21		= 3	
870871	= 31		= 4	
423163	= 19	= 10	= 1	= 22 = 4 unitate
236234	= 20		= 2	
569657	= 38	= 11	= 2	
712984	= 31		= 4	
3283114	= 22		= 4 unitate	

Add figures of each line. The first line adds to 24; now add 2 + 4 = 6; repeat with each line. The fourth line, we find, adds to 19, 1 + 9 = 10 and 1 + 0 = 1. Keep on adding in each case until you have reduced each line to one figure. Next add all of the unitates, which in the above case add to 22 and 2 + 2 = 4, which is the final unitate. In the answer we find that the final unitate is 4 also, which proves the work correct. The figures 24, 21, 31, etc., can be added mentally. A little practice will soon enable you to apply the 9 check figure very quickly.

WATER POWER.

To find the pressure in pounds per square inch of a column of water: Multiply the height of the column in feet by .434. Approximately, we say, that each foot of elevation is equal to ½ pound pressure per square inch. This rule will allow for ordinary friction.

11 CHECK FIGURE.

While the 11 check figure is not infallible, it is reliable in most cases. An operation of this system may be described as follows:

Take two amounts of five figures each, starting at the right-hand; add the first, third and fifth figures and deduct the second and fourth. If the latter exceeds the former, add 11 before deducting. The result is the proof figure.

EXPLANATION OF 11 CHECK FIGURE SYSTEM.

1st amount $484.26	6 + 4 + 4 = 14 2 + 8 = 10 14 — 10 = 4
2nd amount $175.32	2 + 5 + 1 + 11 = 19 3 + 7 + = 10 19 — 10 = 9 4 + 9 = (13)
$659.58	8 + 9 + 6 = 23 5 + 5 = 10 23 — 10 = (13)

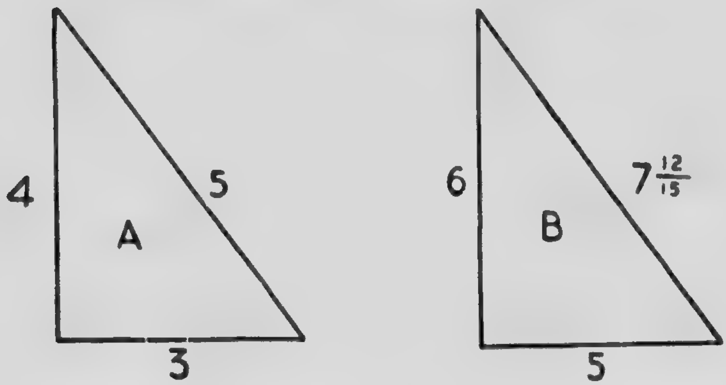
SHORT RULE IN DIVISION.

EXAMPLE.—Divide 270 by 18.

$$\begin{array}{r} 6\underline{)\,270} \\ 3)\,45 \\ 15 = \text{Ans.} \end{array}$$

As the factors of 18 are 6 and 3, we simply divide by 6 and then by 3, which makes it possible to do much work of this kind without a pencil.

SQUARE ROOT WITHOUT A PENCIL.



EXPLANATION.—In Fig. A we have 3 for the base and 4 for the altitude. This will give us 5 even for Hypothenuse. But, where it will not give us an even root for the third side, proceed as follows:

Square the 5 (5 × 5) = 25, and 6 (6 × 6) = 36, find their sum 25 + 36 = 61. Now, as the square root of 61 is 7 (7 × 7) = 49, we write 7 down. We have a remainder of 12. We write that down and, as the square root is between 7 and 8, we simply add the two together, which gives us 15, which completes the fraction.

NOTE—To find the base or altitude when the other two sides are given, subtract square root of one from square root of the other; then proceed as above.

SUBTRACTION OF FRACTIONS.

To subtract 2/7 from 5/9:

$$35 - 18 = 17$$

$$\frac{5}{9} - \frac{2}{7} = 63$$

RULE.—Multiply 5 × 7 and 2 × 9 and subtract for the numerator. Next multiply 9 × 7 = 63, which is the denominator.

CUSTOM HOUSE ADDITION.

	Proof Method.
$57,426.83	20
34,289.21	28
52,341.75	30
98,253.47	29
47,538.62	16
25,073.12	33
	28
$314,923.00	$314,923.00

Add each column separately. Put down both figures, as above, and continue with each column, and add the different sums.

This method of adding does away with the process of carrying, and is very valuable, especially if you are liable to be interrupted while at work. It also enables you to discover an error if one exists.

Each square foot of grate surface is equal to nine feet of heating surface.

TO MULTIPLY 2 FIGURES BY 11.

To multiply any two figures by 11, add the figure on the left to the other two figures. Use their sums for first two figures of the answer, and use the figure to the right for the third figure of the answer. As, 34 × 11; say 34 and 3 = 37, bring down the 4, making 374.

EXAMPLES.—42 × 11 = 462, 63 × 11 = 693, etc. You can add the two together and place their sums between the two, but the above rule is the best, as it does away with carrying when their sums are more than 9.

TO MULTIPLY SEVERAL FIGURES BY 11.

As

$$\begin{array}{r} 352463427 \\ 11 \\ \hline 3877097697 \end{array}$$

First bring down first figure at the right (7), next add the 7 to the next figure (2), making 9. Now drop the 7 and say 2 + 4 = 6, 4 + 3 = 7, 3 + 6 = 9, 6 + 4 = 10. Place 0 in the answer and carry the 1; 4 + 2 = 6 and 1 carried = 7, 2 + 5 = 7, 5 + 3 = 8. Now bring down the 3 at the left, which completes the answer.

To multiply by 111, proceed as above, except that, after bringing down the figure at the right and then adding the first and second figures, you must add the first three figures, then drop the first figure and add the second, third and fourth, then drop the second figure, etc., etc.

AREA OF AN ELLIPSE.

Multiply the product of both diameters by .7854

ADDING METHOD OF DIVISION.

Old Way.

```
       23651 = Ans.
365 | 8632615
      730
      ----
      1332
      1095
      ----
       2376
       2190
       ----
        1861
        1825
        ----
          365
          365
          ---
```

New Way.

```
       23651 = Ans.
365 | 8632615
      1332
       2376
        1861
          365
```

EXPLANATION.—In the short method we find that 365 is contained in 863 twice. Write 2 for first figure in the answer. Now say twice 5 are 10. As it takes 3 to equal the 3 of the 863, write down the 3 and carry the 1. Now say twice 6 are 12 and 1 carried = 13. It takes 3 more to equal the 6; write down the 3 and carry the 1. Next say twice 3 are 6 and 1 carried makes 7. As 1 more is necessary to equal the 8, write down the 1, bring down the 2 and continue as before.

HOLE IN A BOILER.

If a rivet blows out a boiler, to find the amount of water will escape.

RULE.—2½ times the square of the diameter of the hole multiplied by the square root of the pressure in lbs. will give you the number of gallons per minute.

SPEED OF PULLEYS.

The diameter of the driver and driven given to find the revolutions.

Multiply diameter of driver by its number of revolutions, and divide by the diameter of the driven.

The diameter and revolutions of the driver given, to find diameter of the driven that will make any given number of revolutions.

Multiply diameter of driver by its own revolutions and divide by the number of revolutions of the driven.

Multiply diameter of driven by the number of revolutions you wish to make. Divide by revolutions of driver. The quotient will be diameter of driver.

TONS OF HAY IN STACK.

To find the number of tons in a stack of hay, multiply the length in feet by the width in feet, then multiply by half the height in feet and divide by 300.

EXAMPLE.—A hay stack 30 feet long, 20 feet wide and 16 feet high.

```
      30 (long)
      20 (wide)
     ----
     600
       8 (1/2 of height)
     ----
300) 4800 (16
     300
     ----
     1800
     1800
     ----         Ans. 16 tons.
```

ONE BOARD WILL FENCE ONE ACRE.

To find the number of acres in a farm which can be fenced with one board for each acre, making the fence four boards high and the length of the boards to be 11 feet long.

RULE.—As 11 feet is $\frac{2}{3}$ of a rod, $1\frac{1}{2}$ boards = 1 rod, and 4 boards high = $1\frac{1}{2} \times 4 = 6$ boards for each rod of fence. Now, as we must have one board for each acre we must have 6 acres for each rod of fence, and as we cannot multiply boards by acres, we will put the acres into rods. 160 rods (1 acre) + 6 = 960 rods in 6 acres. 16 is our rule. 16 is the only area which gives us the same perimeter.

So we say $16 \times 6 = 96$ and $960 \times 96 = 92{,}160$ acres. Ans.

PROOF.—92,160 acres ÷ 640 = 144 square miles, or 12 miles square, which gives us $12 \times 4 = 48$ miles of fence. 48 miles = $5280 \times 48 = 253{,}440$ feet. $253{,}440 \div 11 = 23{,}040$ boards for each board of height. And $23{,}040 \times 4 = 92{,}160$ boards to fence 92,160 acres; boards 11 feet long and fence 4 boards high.

CUBIC FOOT OF COAL.

A cubic foot of anthracite coal weighs 53 lbs. A cubic foot of bituminous coal weighs 47 to 50 lbs.

SPEED OF A TRAIN.

To find the speed of a train on which you are a passenger. Count the number of times a wheel hits the end of a rail in 20 seconds. The result will be the number of miles per hour.

SQUARE ROOT.

The first step in extracting the square root of a number is to mark off the figures of the number in groups.

Since $1 = 1^2$, $100 = 10^2$, $10{,}000 = 100^2$, and so on, it is evident that the square root of any number between 1 and 100 lies between 1 and 10; of any number between 100 and 10,000 lies between 10 and 100. In other words, the square root of any number expressed by *one* or *two* figures is a number of *one* figure; of any number expressed by *three* or *four* figures is a number of *two* figures, and so on.

If, therefore, an integral number be divided into groups of two figures each, from the right to the left, the number of figures in the root will be equal to the number of groups of figures. The last group to the left may consist of only one figure.

Find the square root of 1225.

```
    12 25 (35
     9
    ----
65)  3 25
     3 25
    -----
```

The first group, 12, contains the square of the tens' number of the root.

The greatest square in 12 is 9, and the square root of 9 is 3. Hence 3 is the tens' figure of the root.

The square of the tens is subtracted, and the remainder, contains twice the tens × the units + the square of the units. Twice the 3 tens is 6 tens, and 6 tens is contained in the 32 tens of the remainder 5 times. Hence 5 is the units' figure of the root. Since twice the tens × the units + the square of the units is equal to (twice the tens + the units) × the units, the 5 units are annexed to the 6 tens, and the result, 65, is multiplied by 5.

The same method will apply to numbers of more than two groups of figures, by considering the part of the root already found as so many tens with respect to the next figure.

Extract the square root of 7890481.

```
      7 89 04 81 (2809
      4
      ------
48)   3 89
      3 84
      --------
5609)   5 04 81
        5 04 81
        -------
```

When the third group, 04, is brought down, and the divisor, 56, formed, the next figure of the root is 0, because 56 is not contained in 50. Therefore, 0 is placed both in the root and the divisor, and the next two figures, 81, are brought down.

If the square root of a number have decimal places the number itself will have *twice* as many.

Thus, if 0.11 be the square root of some number, the number will be $(0.11)^2 = 0.11 \times 0.11 = 0.0121$. Hence if a given square number contain a decimal, and if it be divided into groups of two figures each, by beginning at the decimal-point and marking toward the left for the integral number, and toward the right for the decimal, the number of groups to the *left* of the decimal-point will show the number of *integral* places in the root, and the number of groups to the *right* will show the number of *decimal* places in the root.

Extract the square root of 52.2729.

```
      52.27 29 (7.23
      49
      ----
142)   3 27
       2 84
       -----
1443)  43 29
       43 29
       -----
```

It will be seen from the groups of figures that the root will have one integral and two decimal places.

If a number is not a perfect square, ciphers may be annexed, and an *approximate* value of the root found.

Extract to six places of decimals the square root of 19.

```
      19 00 00 00 (4.358899
      16
      ---
 83)  3 00
      2 49
      ----
 865) 51 00
      43 25
      -----
8708) 7 75 00
      6 96 64
      -------
8716) 78 360
      69 728
      ------
       8 6320
       7 8444
       ------
        78760
```

In this example, after finding four figures of the root, the other three are found by common division. The rule in such cases is, that one less than the number of figures already obtained may be found without error by division, the divisor to be employed being twice the part of the root already found.

CUBE ROOT.

The *cube* of a number is the product of *three* factors, each equal to the number.

The cubes of

	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,
are	1,	8,	27,	64,	125,	216,	343,	512,	729,	1000.

The cube root of a number is one of the *three equal factors* of the number.

Thus the cube roots of

	1,	8,	27,	64,	125,	216,	343,	512,	729,	1000,
are	1,	2,	3,	4,	5,	6,	7,	8,	9,	10.

The cube root of a number is indicated by $\sqrt[3]{\ }$, or by the fraction $\frac{1}{3}$ written above and to the right of the number.

Thus, $\sqrt[3]{343}$, or $343^{\frac{1}{3}}$, means the cube root of 343.

Since $35 = 30 + 5$, the cube of 35 may be obtained thus:

$$
\begin{array}{l}
30 + 5 \\
30 + 5 \\
\hline
30^2 + (30 \times 5) \\
\quad + (30 \times 5) + 5^2 \\
\hline
30^2 + 2(30 \times 5) + 5^2 \\
30 + 5 \\
\hline
30^3 + 2(30^2 \times 5) + (30 \times 5^2) \\
\quad\quad (30^2 \times 5) + 2(30 \times 5^2) + 5^3 \\
\hline
30^3 + 3(30^2 \times 5) + 3(30 \times 5^2) + 5^3
\end{array}
$$

$$
\begin{array}{rr}
30^3 = & 27{,}000 \\
3(30^2 \times 5) = & 13{,}500 \\
3(30 \times 5^2) = & 2{,}250 \\
5^3 = & 125 \\
\hline
 & 42{,}875
\end{array}
$$

Hence the cube of any number composed of tens and units contains four parts:

I. The cube of the tens.

II. Three times the product of the square of the tens by the units.

III. Three times the product of the tens by the square of the units.

IV. The cube of the units.

In extracting the cube root of a number, the first step is to mark off the figures of the number in groups.

Since $1 = 1^3$, $1000 = 10^3$, $1{,}000{,}000 = 100^3$, and so on, it follows that the cube root of any number between 1 and 1000, that is, of any number that has *one*, *two*, or *three* figures, is a number of *one* figure; and that the cube root of any number between 1000 and 1,000,000, that is, of any number that has *four*, *five* or *six* figures, is a number of *two* figures, and so on.

If, therefore, an integral number be divided into groups of three figures each, from right to left, the number of figures in the root will be equal to the number of groups. The last group to the left may consist of one, two, or three figures.

Extract the cube root of 42875.

$$\begin{array}{rr|l}
 & & 42\ 875\ (35 \\
 & & 27 \\
3 \times 30^2 = & 2700 & 15\ 875 \\
3 \times (30 \times 5) = & 450 & \\
5^2 = & 25 & \\
\hline
 & 3175 & 15\ 875
\end{array}$$

Since 42875 consists of two groups, the cube root will consist of two figures.

The first group, 42, contains the cube of the tens' number of the root. The greatest cube in 42 is 27, and the cube root of 27 is 3. Hence 3 is the tens' figure of the root.

The remainder, 15875, resulting from subtracting the cube of the tens, will contain three times the product of the square of the tens by the units + three times the product of the tens by the square of the units + the cube of the units.

Each of these three parts contains the units' number as a factor.

Hence the 15875 consists of two factors, one of which is the units' number of the root; and the other factor is three times the square of the tens + three times the product of the tens by the square of the units + the square of the units. The larger part of this second factor is three times the square of the tens.

And, if the 158 hundreds of the remainder be divided by the $3 \times 30^2 = 27$ hundredths, the quotient will be the units' number of the root.

The second factor can now be completed by adding to the 2700 $3 \times (30 \times 5) = 450$ and $5^2 = 25$.

The same method will apply to numbers of more than two groups of figures, by considering the part of the root already found as so many tens with respect to the next figure of the root.

Extract the cube root of 57512456.

		57 512 456 (386
		27
$3 \times 30^2 =$	2700	30 512
$3 \times (30 \times 8) =$	720	
$8^2 =$	64	
	3484	27 872
		2 640 456
$3 \times 380^2 =$	433200	
$3 \times (380 \times 6) =$	6840	
$6^2 =$	36	
	440076	2 640 456

If the cube root of a number have decimal places, the number itself will have *three times* as many.

Thus, if 0.11 be the cube root of a number, the number is $0.11 \times 0.11 \times 0.11 = 0.001331$. Hence, if a given number contain a decimal, and if the figures of the number be divided into groups of three figures each, by beginning at the decimal-point and marking toward the left for the integral number and toward the right for the decimal, the number of groups toward the *left* from the decimal-point will show the number of *integral* places in the root, and the number of groups toward the *right* will show the number of *decimal* places in the root.

CUBIC CONTENTS OF A SPHERE.

To find the cubic contents of a sphere when the diameter is known, proceed as follows: Multiply the cube of the diameter by .5236.

CHRONOLOGY OR COMPUTING TIME.

The Julian Calendar, or Old Style, established by Julius Cæsar 46 B.C., was in use in all Christian countries until the year 1582, when Pope Gregory XIII. decreed that in all Catholic countries the Julian Calendar should be abolished and a correction of 10 days be made making the 5th of the month of October in that year the 15th; and also that instead of reckoning every four years a leap year the centurial years, as 1600, 1700, 1800 should not be leap years unless divisible by 400. It will thus be seen that 1600 was a leap year according to the New Style, but 1700, 1800 and 1900 are not. The next centurial leap year will be 2000. The New Style was not adopted in England and America until 1752. The Old Style is still used in Russia.

According to the Old Style every fourth year is counted a leap year and an extra day is added to February. As the true solar year does not contain exactly 365¼ days this error was the cause of the adoption of the New Style, which is sometimes called the Gregorian Calendar, but which was really devised by Aloysius Lilius, or Luigi Lilio Ghiraldi, a learned astronomer and physician of Naples, who died before its adoption. It devolved upon Clavius to make all the calculations necessary for its verification, and by whom it was completely developed and explained in a large folio treatise of 800 pages, published in 1603.

It is our mission to strip the long methods, tables, etc., of the folio treatise of their dominical letters, technical terms, etc., and to present the simplest rules for finding the day of the week of any date, Easter Sunday, and the principal Church feasts depending on Easter, Age of Moon, etc.

OLD STYLE.

To find the day of the week corresponding to any date, according to the Julian Calendar, or Old Style:—

RULE.—To the given year add its one-fourth part (discarding fractions, if any)—in leap years add its one-fourth part less one—the number of days that have elapsed since the beginning of the given year, and 5. The excess of sevens signifies the day of the week—1 indicating Sunday, 2 Monday, etc., while a remainder of 0 indicates Saturday.

The execution of Charles I. occurred January 30th, 1649; required the day of the week.*

Operation.

```
 1649 = Year.
  412 = Leap years.
   30 = Days since beginning of year.
    5
-------
7)2096
-------
  299 — 3 = Tuesday.
```

Columbus discovered America Oct. 12th, 1492; required the day of the week.

Operation.

```
 1492 = Years.
  372 = Leap years, less one.
  286 = Days since beginning of year.
    5
-------
7)2155
-------
  307 — 6 = Friday.
```

EXPLANATION.—When the year is exactly divisible by 4 it is always a leap year, Old Style. 1492 being a leap year, we must be careful and count the extra day for February; also to deduct 1 from the leap years. In this case we have 286 days from the beginning of the year to the 12th of October.

---

* This being an English date it is, of course, counted O.S., as it happened prior to 1752.

NEW STYLE.

In devising a rule for telling the day of the week of any date according to New Style which is our present method of reckoning time—we will first present a rule for the present century, which is quite easy, and as there are no numbers to remember it should be known by every one, as it will not only answer as a calendar for daily use when no printed calendar is at hand, but all dates, past and future, can be easily ascertained. Corrections can be made from it for any century.

* RULE.—To the given year add its one-fourth part (discarding fractions, if any)—in leap year add its one-fourth part **less one**—and the number of days that have elapsed since the beginning of the given year, inclusive. Divide their sum by 7. The excess of sevens signifies the day of the week. 1 signifies Sunday, 2 Monday, etc. An excess of 0 indicates Saturday.

The battle of New Orleans was fought Jan. 8th, 1815; find the day of the week.

Operation.

1815 = Years.
453 = Leap years.
8 = Days elapsed since beginning of year.

7)2276

325 — 1 = Sunday.

* In leap year do not forget the 29th of February when adding the number of days that have elapsed since the beginning of the year. Except in the case of the centurial years before mentioned leap year can always be told after dividing the year by 4, when the quotient is a whole number. Remember to deduct *one* in such years.

Find the day of the week of July 4th, 1876.

Operation.

1876	Years.
468	Leap years *less one*.
31	Days in January.
29	Days in February.
31	Days in March.
30	Days in April.
31	Days in May.
30	Days in June.
4	Days in July.

7)2530

361 3 Tuesday.

EXPLANATION. If the student will remember that for dates in the past century add 2, and for the next century add 5 to the operation before dividing by 7 the dates for 300 years can be easily ascertained. Thus, suppose we wish to find on what day of the week occurred the signing of the declaration of independence, July 4th, 1776. We proceed as above, with the date in 1876 and add 2 to the sum, which gives 2532. 2532 ÷ 7 = 361, and a remainder of 5, which signifies Thursday, answer. In like manner, for the same date in 1976 we add 5 and get 2535, which divided by 7, as before, gives an excess of 1, which signifies that July 4th, 1976, will fall on Sunday.

The rule for telling the number of days to add for any century, New Style, is as follows: Find the figure to add for dates between 2000 and the century following. We reject the first two ciphers and we have 20. From this subtract 16 and multiply the remainder (4) by 5¼ (rejecting fractions) we get 21. We now add 4 to this result, which gives 25. Divide by 7, and we have 3 and a remainder of 4. The remainder is the figure sought.

A rule which applies to the present century, and by making corrections as in the preceding rule to all cen-

turies—New Style—can be applied mentally. To do this, figures which we shall term "excess figures" of the months must be memorized. They are as follows:—

0	1	2	3	4	5	6
June	Sept. Dec.	April July	Jan.* Oct.	May	Aug.	Feb.* Nov. March

RULE TO FIND THE HORSEPOWER OF A LOCOMOTIVE.

Multiply the area of the piston by the pressure per square inch, which should be taken as two-thirds of the boiler pressure; multiply this product by the number of revolutions per minute. Multiply this by twice the length of the stroke in feet or inches; if in inches they must be divided by 12. Multiply this product by 2 and divide by 33,000. The result will be the power of the locomotive.

Example—

Cylinder .... 19 inches.
Stroke .... 24 inches.
Diameter of Drivers.......... 54 inches.
Running Speed, 20 miles per hour.
Area of Piston, 283.5 square inches.
Boiler Pressure, 130 pounds per square inch.
Maximum Pressure in Cylinders, 80 pounds.

$$\frac{283.5 \times 80 \times 4 \times 124 \times 2}{33{,}000} = 681.6 \text{ horsepower.}$$

* January and February are each called **one less** in leap years.

RULE TO FIND THE HORSEPOWER OF A STATIONARY ENGINE.

A horsepower is 33,000 pounds raised one foot high in one minute. To find the horsepower of any engine, first find the area of the piston head face, then multiply the answer by the average pounds pressure per square inch, then multply by the number of feet travelled in one minute, and divide by 33,000; this will give the horsepower.

EXAMPLE.—Diameter of cylinder, 12 inches.

12 × 12 = 144 × .7854 = 113.0976, area of piston head face.

```
Average pressure ........      50
                            ------
                            5650
Travel pist. in ft. per min.  300
                            ------
                  33000)1695000(51 12-33 h.p.
                        165000
                        ------
                         45000
                         33000
                        ------
                         12000
```

Power.—The units of force, distance and time are respectively 1 pound, 1 foot and 1 minute.

Man Power.—One man's power = .0909 horsepower = 3,000 units of work = 3,000 pounds raised vertically 1 foot in 1 minute, or its equivalent.

Horsepower.—One horsepower = 11 men's power = 33,000 units of work = 33,000 pounds raised vertically 1 foot in 1 minute, or its equivalent.

RULES FOR FIGURING THE SAFETY VALVES OF STEAM BOILERS.

To Find the Pressure when the Area of Valve, the Weight of Lever, Valve and Stem, the Distance Fulcrum is from Valve, and Weight of Ball is Known.—Divide fulcrum into length of lever, multiply answer by weight of ball, add weight of lever, valve and stem, and divide by area of valve. Answer will be steam pressure.

EXAMPLE.—Weight of ball, 50 pounds; weight of lever, valve and stem, 30 pounds; diameter of valve, $2\frac{1}{4}$ inches; length of lever, 20 inches; fulcrum, 4 inches.

```
   2.25              4)20
   2.25              ----
 ------                 5
 5.0625                50
  .7854              ----
--------              250
3.97608750 area        30
                    ------
                  3.9)280.0
                  ---------
                      71 31/39 lbs. pressure.
```

Add as many ciphers to the dividend as there are decimals in the divisor and divide as whole numbers.

DIVISION OF MIXED NUMBERS.

$63\frac{2}{3} \div 4$

$4)\,63\frac{2}{3}$

$15\frac{11}{12}$

RULE.—4 into 6 = 1, 2 remains; 4 into 23 = 5, 3 remains. 3 (remainder) × 3 (denominator) + 2 (numerator) = 11, which is numerator of your answer. And 4 (divisor) × 3 (denominator) = 12, completing your answer.

MENSURATION.

Diameter of a circle × 3.1416 = Circumference.

Radius of a circle × 6.283185 = Circumference.

Square of the radius of a circle × 3.1416 = Area.

Square of the diameter of a circle × 0.7854 = Area.

Square of the circumference of a circle × 0.07958 = Area.

Half the circumference of a circle × half its diameter = Area.

Circumference of a circle × 0.159155 = Radius.

Square root of the area of a circle × 0.56419 = Radius.

Circumference of a circle × 0.31831 = Diameter.

Square root of the area of a circle × 1.12839 = Diameter.

Diameter of a circle × 0.86 = Side of inscribed equilateral triangle.

Diameter of a circle × 0.7071 = Side of an inscribed square.

Circumference of a circle × 0.226 = Side of an inscribed square.

Circumference of a circle × 0.282 = Side of an equal square.

Diameter of a circle × 0.8862 = Side of an equal square.

Base of a triangle × by ½ the altitude = Area.

Multiply both diameters and .7854 together = Area of an eclipse.

Surface of a sphere × by ⅙ of its diameter = Solidity.

Circumference of a sphere × by its diameter = Surface.

Square of the diameter of a sphere × 3.1416 = Surface.

Square of the circumference of a sphere × 0.3183 = Surface.

Cube of the diameter of a sphere × 0.5236 = Solidity.

Cube of the radius of a sphere × 4.1888 = Solidity.

Cube of the circumference of a sphere × 0.016887 = Solidity.

Square root of the surface of a sphere × 0.56419 = Diameter.

Square root of the surface of a sphere × 1.772454 = Circumference.

Cube root of the solidity of a sphere × 1.2407 = Diameter.

Cube root of the solidity of a sphere × 3.8978 = Circumference.

Radius of a sphere × 1.1547 = Side of inscribed cube.

Square root of (1-3 of the square of) the diameter of a sphere = Side of inscribed cube.

Area of its base × by 1-3 of its altitude = Solidity of a cone or pyramid, whether round, square, or triangular.

Area of one of its sides × 6 = Surface of a cube.

Altitude of trapezoid × ½ the sum of its parallel sides = Area.

TWENTIETH CENTURY RULE

346
523
———
180958

Say, 3 × 6 = 18. Write 8 down and carry the 1. Next say 3 × 4 = 12, and 1 carried makes 13. 2 × 6 = 12. Add 13 + 12 = 25. Write the 5 down and carry the 2. Now take 3 × 3 = 9, and 2 carried makes 11. 5 × 6 = 30 and 2 × 4 = 8. Add 11 + 30 + 8 = 49. Write the 9 down and carry the 4. Next take 2 × 3 = 6 and 4 carried makes 10. 5 × 4 = 20 add 10 + 20 = 30. Write the 0 down and carry the 3. 5 × 3 = 15 and 3 carried = 18, which makes the answer complete.

SIDE OF AN INSCRIBED SQUARE.

To find the side of the largest square that can be inscribed in a given circle, multiply the diameter by .707107—or multiply the circumference by .22508.

SCRIPTURAL MEASURES OF LENGTH,

With English Equivalents.

The great Cubit was 21.888 ins. (1,824 ft.), and the less 18 ins. A span the longer = ½ a cubit = 10.944 ins. = .912 ft. A span the less = ⅓ of a cubit = 7.296 ins. = .608 ft. A hand's breadth = ⅙ of a cubit = 3.684 ins. = .304 ft. A finger's breadth = 1.24 of a cubit .912 ins. .076 ft. A fathom = 4 cubits = 7.296 ft. *Ezekiel's* Reed = 6 cubits = 10.944 feet. The mile 4,000 cubits = 7,296 ft. The Stadium, 1/10 of their mile = 400 cubits 729.6 ft. The Parasang, 3 of their miles = 12,000 cubits, or 4 English miles and 580 ft. 33.164 miles was a day's jourrey—some say 24 miles; and 3,500 ft. a Sabbath day's journey; some authorities say 3,648 ft.

SCRIPTURAL MEASURES OF CAPACITY,

With English Equivalents.

The Chomer or Homer in King James' translation was 75.625 gals. liquid, and 32.125 pecks dry. The Ephah or Bath was 7 gals. 4 pts., 15 ins. sol. The Seah, ⅓ of Ephah, 2 gals. 4 pts., 3 in sol. The Hin = ⅙ of Ephan, 1 gal. 2 pts., 1 in. sol. The Omer = 1/10 of Ephah, 5 pts., 0.5 ins. sol. The Cab = 1/18 of Ephah, 3 pts., 10 ins. sol. The Log = 7 1/72 of Ephah, ½ pt., 10 ins. sol. The metretes of *Syria* (*John* ii. 6) = Cong. Rom. 7⅛ pts. The Cotyla Eastern = 1/100 of Ephah, ½ pt. 3 in. sol. This Cotyla contains just 10 ozs. Avoirdupois of rain water. Omer, 100; Ephah, 1,000; Chomer or Homer, 10,000.

DIVISIONS OF TIME.

TRUE TIME.—Two kinds of time are used in almanacs—clock or meantime in some, and apparent or sun-time in others. Clock-time is always right, while sun-time varies every day. People generally suppose it is twelve o'clock when the sun is due south, or at a properly made noon-mark. This is a mistake; the sun very seldom being on the meridian at twelve o'clock.

A Solar day is measured by the rotation of the Earth upon its axis, and differs in length, owing to the ellipticity of the Earth's orbit and other causes, but a mean solar day, as recorded by clock time, is 24 hours long.

An Astronomical day begins at noon, and is counted from the first to the twenty-fourth hour.

A Civil day commences at midnight, and is counted from the first to the twelfth hour.

A Nautical day is counted as a Civil day, but commences, like an Astronomical day, at noon-time.

A Calendar month varies from 28 to 31 days.

A mean Lunar month is 29 days 12 hours 44 mins. 2 secs. and a small fraction.

A Year is divided into 365 days.

A Solar year, which is the time occupied by the passage from one vernal equinox to another, consists of 365.24244 solar days, or 365 days, 5 hours, 48 minutes and 49.536 seconds.

A Julian year is 365 days, a Gregorian year is 365.2425 days. Every fourth year is Bissextile, or leap year, and is 366 days. The error of the Gregorian computation amounts only to one day in 3575.4286 years.

To ascertain the length of day or night at any time of the year add 12 hours to the time of the Sun's setting, and from the sum subtract the time of rising, the remainder will be the length of the day.

Subtract the time of setting from 12 hours, and to the remainder add the time of rising next morning and you have the length of the night.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

With Their Equivalents According to the System in Use.

MEASURES OF LENGTH.

Metric Denominations and Values.		Equivalents in Denominations in use.
Myriameter . =	10,000 meters	.. = 6.2137 miles.
Kilometer ... =	1,000 meters	.. = 0.62137 m. or 3,280 ft. 10 in.
Hectometer .	100 meters	.. = 328 feet and 1 inch.
Dekameter ..	10 meters	.. = 393.7 inches.
Meter ..... =	1 meter	... = 39.37 inches.
Decimeter .. =	.1 of a meter	.. = 3.937 inches.
Centimeter .. =	.01 of a meter	.. = 0.3937 inch.
Millimeter .. =	.001 of a meter	.. = 0.0394 inch.

MEASURES OF SURFACE.

Hectare .... =	10,000 square meters	.. = 2,471 acres.
Are .... =	100 square meters	.. = 119.6 square yards.
Centare .... =	1 square meter	.. = 1,550 square inches.

MEASURES OF CAPACITY.

Names.	No. Liters.	Cubic Measure.	Dry Measure.	Wine Measure.
Kiloliter .. =	1,000. =	1 meter .. =	1,308 cu. yds. =	264.17 galls.
Hectoliter . =	100. =	.1 meter .. =	2 bu. 3.35 pks. =	26. [illegible] galls.
Decaliter . =	10. =	10 decim . =	9.08 quarts .. =	2.6417 galls.
Liter .... =	1. =	1 decim . =	0.908 quart .. =	1.0567 qts.
Deciliter . =	.1. =	.1 decim . =	6.1022 cu. in. =	0.845 gill.
Centiliter =	.01. =	10 centim. =	0.6102 cu. in. =	0.338 fl'd oz.
Milliliter . =	.001. =	1 centim. =	0.061 cu. in.. =	0.27 fluid dr.

WEIGHTS.

Names.	No. Grams.	Weight of what quantity of water at maximum density.	Avoirdupois Weight.
Millier or tonneau.	= 1,000,000. .	= 1 cubic meter. .	2204.6 lbs
Quintal	100,000.	1 hectoliter . .	220.46 lbs
Myriagram	10,000. .	10 liters	= 22.046 lbs
Kilogram or kilo. .	1,000. .	1 liter	2.2046 lbs.
Hectogram	100. .	1 deciliter . .	3.5274 oz
Dekagram	10. .	10 c. centimet . .	0.3527 oz
Gram	1. .	1 c. centimet .	= 15.432 grs
Decigram	.1. . =	1 c. centimet .	1.5432 grs.
Centigram	.01. .	10 c. millimet .	0.1543 gr.
Milligram . . . . . . =	.001. . =	1 c. millimet .	0.0154 gr.

COMMON NAMES OF CHEMICAL SUBSTANCES

Common Names.	Chemical Names.
Aqua Fortis	Nitric Acid.
Aqua Regia	Nitro-Muriatic Acid.
Blue Vitriol	Sulphate of Copper.
Cream of Tartar	Bitartrate Potassium.
Calomel	Chloride of Mercury.
Chalk	Carbonate Calcium.
Salt of Tartar	Carbonate of Potassa.
Caustic Potassa	Hydrate Potassium.
Chloroform	Chloride of Gormyle.
Common Salt	Chloride of Sodium.
Copperas, or Green Vitriol .	Sulphate of Iron.
Corrosive Sublimate	Bi-Chloride of Mercury.
Diamond	Pure Carbon.
Dry Alum	Sulphate Aluminum and Potassium.

Common Names.	Chemical Names.
Epsom Salts	Sulphate of Magnesia.
Ethiops Mineral	Black Sulphide of Mercury.
Fire Damp	Light Carburetted Hydrogen.
Galena	Sulphide of Lead.
Glauber's Salt	Sulphate of Sodium.
Glucose	Grape Sugar.
Goulard Water	Basic Acetate of Lead.
Iron Pyrites	Bi-Sulphide Iron.
Jeweller's Putty	Oxide of Tin.
King's Yellow	Sulphide of Arsenic.
Laughing Gas	Protoxide of Nitrogen.
Lime	Oxide of Calcium.
Lunar Caustic	Nitrate of Silver.
Mosaic Gold	Bi-Sulphide of Tin.
Muriate of Lime	Chloride of Calcium.
Nitre of Saltpetre	Nitrate of Potash.
Oil of Vitriol	Sulphuric Acid.
Potash	Oxide of Potassium.
Realgar	Sulphide of Arsenic.
Red Lead	Oxide of Lead.
Rust of Iron	Oxide of Iron.
Salmoniac	Muriate of Ammonia.
Slacked Lime	Hydrate Calcium.
Soda	Oxide of Sodium.
Spirits of Hartshorn	Ammonia.
Spirit of Salt	Hydro-Chloric or Muriatic Acid.
Stucco, or Plaster of Paris	Sulphate of Lime.
Sugar of Lead	Acetate of Lead.
Verdigris	Basic Acetate of Copper.
Vermillion	Sulphide of Mercury.
Vinegar	Acetic Acid (Diluted).
Volatile Alkali	Ammonia.
Water	Oxide of Hydrogen.
White Precipitate	Ammoniated Mercury.
White Vitriol	Sulphate of Zinc.

MULTIPLICATION MADE EASY.

To multiply two figures by two figures, as 24 × 35 = 840. Simply double one and half the other, as 12 × 70 = 840.

SPECIFIC GRAVITY.

The specific gravity of a substance is the number found by dividing the weight of the substance by the weight of water of equal bulk.

NOMINAL HORSE-POWER.

Multiply the diameter of the cylinder in inches by the length of the stroke in inches and divide by 30. As, 30 circular inches = 1 horse-power.

ANY PART OF A TON.

1,620 lbs. of coal @ $8.00 per ton will cost 1,620 × 4 = 6.48.0.

1,620
4

$6.48.0 Ans.

Multiply number of lbs. by one-half the ton price in dollars, which gives us the price in dollars, cents and mills exactly.

DO FIGURES LIE?

A	sells	30	apples	@	2	for	1c.		15c.
B	"	30	"	"	3	"	1c.	=	10c.
A and B	"	60	"	"	5	"	2c.	=	25c.
C	"	60	"	"	5	"	2c.	=	24c.
								Loss	1c.

To find the difference in speed of the top and bottom of a buggy wheel: Put a pencil mark on the flange at the bottom and a mark on the pavement. Put a pencil mark on the flange at the top also. After making all marks carefully, move the buggy until the mark on the top of the wheel has travelled one foot; then measure the distance the bottom has moved, and compare them.

RULE TO FIND THE HORSEPOWER OF A BOILER.

Always find the number of square inches and divide by 144, which gives the square feet of heating surface, and divide by 15 square feet, which is an average allowance for one horsepower of a boiler. Divide the horsepower by 2; you will have the proper grate surface and allow $\frac{1}{2}$ square inch of safety valve to each square foot of grate surface. Generally, from $\frac{1}{2}$ to $\frac{3}{4}$ of a square foot of grate surface is allowed to each horsepower of a boiler.

MULTIPLICATION BY PERCENTAGE.

At $12\frac{1}{2}$c. per yard, how many yards can be bought for $8.00? $8 \times 8 = 64$ Ans.

EXPLANATION.—$12\frac{1}{2} = \frac{1}{8}$ of $1.00, consequently $1.00 will buy 8 yards and $8.00 will buy $8 \times 8 = 64$ yards.

TO WEIGH CATTLE BY MEASUREMENT.

You will be surprised to find how near you can tell the weight of a cow by measurement.

RULE.—Multiply the square of the girth by the length from the fore part of the shoulder blade to the end of the back bone at the tail. Multiply by 7 and divide by 2.

BUYING GOODS BY DOLLAR'S WORTH.

$16\frac{1}{2}$ lbs. of sugar for one dollar. How many lbs. for 40c.?

$$\begin{array}{r} 16\frac{1}{2} \\ 40 \\ \hline 20 \\ 64 \\ \hline 6.60 \end{array}$$

Answer, $6\frac{6}{10}$.

RULE.—Multiply number of lbs. for one dollar by number of cents you wish to spend and your answer is the number of lbs. you should receive.

HELPFUL QUOTATIONS.

NAPOLEON BONAPARTE.

Born 1769. Died 1821.

Victory belongs to the most persevering.

I have only one counsel for you—Be Master.

OLIVER GOLDSMITH.

Born 1728. Died 1774.

People seldom improve when they have no other model but themselves to copy after.

GEORGE WASHINGTON.

Born 1732 Died 1799.

To be prepared for war is one of the most effectual means of preserving peace.

HENRY LONGFELLOW.

Born 1807. Died 1882.

Look not mournfully into the past, it comes not back again; wisely improve the present, it is thine.

WILLIAM E. GLADSTONE.

Born 1809. Died 1898.

To train the mind should be the first object and to stock it the next.

BENJAMIN FRANKLIN.

Born 1706. Died 1790.

An investment in knowledge always pays the best interest.

If you would not be forgotten as soon as you are dead either write things worth reading, or read things worth writing.

If a man empties his purse into his head, no man can take it away from him.

WANTED

Agents to sell this book.

Exclusive territory given to live men who can demonstrate.

All communication regarding terms, territory wanted, etc., will receive prompt attention if addressed to

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